INSTRUCTIONAL DESIGN AND MULTIMEDIA – CASE STUDIES

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The University of British Columbia (UBC) is situated in Vancouver, on Canada's west coast. UBC is a large publicly-funded university established in 1925. It has more than 30,000 full-time undergraduate students, 6000 graduate students and 2000 faculty. Over the past decade, it has consistently ranked at or near the top in Canada in terms of the per capita research funding received by its faculty.

Since 1994, the UBC has invested heavily in information technology, both in upgrading the campus infrastructure and in promotion of the development of innovative teaching and learning projects. Some initiatives in the infrastructure area have been unproductive, primarily because technology was purchased as a "solution looking for a problem". Some multimedia projects have also floundered, either because of insufficient funding, lack of reward, insufficient technical support or insufficient instructional design input for the project. However, many infrastructure and instructional technology projects have been successful and together have contributed to advancement of instructional technology as an important element of teaching and learning at the University.

One particularly crucial issue has emerged from this exercise; namely, the importance of good instructional design to the success of multimedia projects. In this paper, I will analyze a selection of UBC multimedia projects in Biomechanics, Geology, Law, History, Botany and Germanic Studies, and point out why I feel that these projects have been successful. My analysis suggests that, knowingly or unknowingly, the leaders of these projects have been able to incorporate three key learning principles into their work. These principles, which also have been officially adopted by the Ministry of Education in British Columbia, state that:

- Learning requires active participation
- Learners learn in different ways; they are at different stages and progress at different rates
- Learning is an individual and social contextual process

The projects examined in this analysis have employed a wide range of technologies, including Web-based asynchronous discussion groups, collaborative on-line work areas for students, automated self-testing questions and on-line resources, including text, static graphics and

interactive graphics. In terms of design philosophy, the faculty members heading up successful projects tended to employ a facilitative teaching approach, acting as a "guide on the side" rather than as a "sage on stage".

The analyses presented below are based mainly on exit surveys of students and on the instructors' anecdotal impressions rather than on rigorous research studies. Nevertheless, a consistent pattern becomes apparent: project success results from creation of an active, learner-centred environment in at least one major component of each project.

CASE STUDIES

1. Human Kinetics - *Biomechanics on the Web*.

In this one-semester course (thirteen weeks), the instructor, Professor David Sanderson, and his team of staff and undergraduate students, prepared a set of annotated, graphically illustrated course notes accompanied by a series of human movement-related laboratory simulations. The simulations, depicting movement situations such as running, cycling and jumping, were accessed using a Web browser. The simulations were based on real data that were gathered as part of the biomechanics research being undertaken in Dr. Sanderson's laboratory.

The primary reason for developing these simulations was to provide students with a substitute for direct laboratory experience, since the large numbers in the course (approximately 80 students) and competing demands for access to laboratory space, meant that the undergraduate laboratories would either have to be limited to passive demonstrations or be deleted altogetherAnother important motivation, however, was the opportunity to allow students to manipulate variables that are not possible to manipulate in real life. For example, students could watch a Quicktime movie of a cyclist and then add overlays of muscles and skeleton to clarify patterns of muscle activation and pedal forces during a cycling rotation.

The on-line course notes were provided as a resource that the students could access at their own pace and at times convenient to them. These notes were, according to Dr. Sanderson, more effective than his previous set of notes, because three students who had already taken the course, made modifications to them in areas they identified as problem areas for most students. The students also incorporated graphics that added both visual interest and clarification. Because the notes were available on the Web, the instructor was able to change his method of delivery from "covering all the content" in three class meetings per week, to highlighting and investigating particularly important and/or difficult concepts in two class meetings per week. For the third scheduled meeting, students brought to the class "real-life" problems, often taped from television sporting events, that illustrated biomechanics principles or questions, e.g., what forces are in play when skateboarders jump up onto a platform? Although these third sessions might have been

viewed by the students as optional, they were, in fact, well attended.

Course Successes

- active participation - lab simulations, on-line problem sets, weekly discussion sessions
- individual learning - on-line materials
- learning in a social context - weekly student-initiated discussion sessions.
- multiple learning modes - on-line alone, on-line in groups, in class (lecture and discussion)

The instructor also observed that students in this version of the course submitted more complex and detailed laboratory reports, perhaps as a result of spending more "active time" with the materials.

Future directions

Students reported that ready access to computers could be a problem, and that they did not always know how to use some of the required programs. In response to these concerns, lab hours have been extended into the evening, and the instructor holds an introductory session on how to access the materials and use the programs.

Building on the structure of the initial movement examples, the course team has also added a greater variety of movement examples.

In order to help students engage more actively with the simulations, the program no longer displays pre-generated graphs. Instead, students generate their own graphs by applying the principles illustrated in the computerized animations.

2. Law - *Evidence on the World Wide Web*

In September 1996, Professors MacCrimmon and Boyle launched the initial version of this on-line course. Twenty students (the maximum allowed) registered for the course within one day of its availability. They knew that it would be primarily a "distance learning" experience requiring access to an Internet-connected computer capable of running the Netscape browser.

The course Web-site consisted primarily of readings on specific topics in the area of legal evidence together with discussion "rooms", running under the HyperNews program which allowed threaded, asynchronous discussion to take place. Students were guided through the course in a structured manner as topics for discussion were posted on specific dates. Discussion on each topic was limited to a certain timeframe. Students were required to contribute a minimum number of discussion points to a topic and were given some explicit guidelines as to what constituted appropriate, meaningful contributions.

Professors Marilyn MacCrimmon and Christine Boyle, write, "This [Evidence] is an area of law

which seems particularly well-suited to a WWW format with a large element of computer conferencing. It is complex and analytically challenging, so time for reflection before discussion is important. Not only must students assimilate large amounts of information, they must be able to apply their knowledge in a variety of contexts. A course on the WWW can provide hot links to a range of information such as case law, statutes, legislative debates, news reports and trial transcripts. As well, Evidence is one interface between law and other disciplines, so easy access to social science information is important. The challenge in a traditional class is to provide a wide range of information while giving sufficient time for reflection and problem solving. Computer conferencing provides opportunities for ease of access while encouraging reflective application, analysis, synthesis and evaluation of knowledge."

Course Successes

- individual learning – working alone, from home
- social context - computer conferencing discussion groups/course
- learning at different rates - time to reflect on contributions, ability to review the discussion before responding
- active participation - discussions contained warmth and humour; the tone of the discussions was "friendly, lively, supportive and stimulating"

I believe that the following quotation from one of the students in the course illustrates how well this project reflected the principles of learning: "I am really finding that taking this course has proven to be a very useful learning tool for me. With the emphasis on personal and individual achievement in law school, the group work involved in contributing to discussion groups has exposed me to the different problem-solving methods of my classmates. I find this particularly useful, in that normally, we are evaluated by a 100 per cent final [exam] that doesn't really allow us to evaluate where we may have gone wrong in our analysis. This allows us the option to approach problems in a different way, one that we may have seen our classmates utilizing."

Suggestions for change

The instructors plan to provide even more opportunities for students to actively participate in the on-line course. To this end, they wish to incorporate multiple choice questions and design more problems and discussion questions.

They would also like to increase the number of students who could take the on-line course and are investigating, together with their students, concepts and examples in the area of problem solving, computer conferencing and teaching on the Web, to achieve this.

3. History - *World History on the Web and in Multimedia*

This history course, designed for first-year students by Professor Robert Kubicek, was new in September 1996. Students met as a class twice per week. Once a week, they met in small

discussion groups. In the large class meetings, Dr. Kubicek incorporated multimedia elements into the course and arranged a classroom that had both an Internet connection and computer projection facilities. Class presentations were enhanced by computer display of maps demonstrating migration patterns, by projecting relevant images and graphs and by playing audio and video clips that provided compelling, "real-life" examples of the historical record. These additional non-textual resources allowed students to experience the migration and mingling of peoples across time and space in a much more visual manner, using tools to which they easily relate.

With the assistance of Bonita Bray, a graduate student familiar with computer-based learning, Professor Kubicek next began developing a Web-site for his course using WebCT (WebCourse Tools). This UBC-developed (Murray Goldberg and team) software allows non-computer scientists to easily develop sophisticated Web-based teaching and learning resources.
The original plan for developing the World History Web-site was for the instructor and teaching assistant to develop glossaries, links to relevant Web-sites as well as other resources, and to direct the students to these.

As an additional experiment, the instructor added one "on-line" discussion group, made up of eight volunteers who had guaranteed access to the Net. Initially asked to examine the materials that had already been put up on the Web, the on-line group soon became participants in their creation. The students collaborated in developing the glossary items, exchanging initial definitions over the Net, making suggestions for improvement and finally, achieving consensus as to the final definition. They moved from contributing to the on-line glossary to finding and vetting relevant Web-sites to link with the course material. They also learned to critically evaluate the Web-sites they located, using such criteria as content, relevance, provenance and design. Their efforts in finding and evaluating relevant Web-sites were recognized by having those sites published on the course Web-site along with an acknowledgment of the students who "found" the site.

Using WebCT's chat tool, the on-line group also discussed questions posed in the lecture. The instructors joined these on-line chats toward their conclusion.
By the end of the course a number of other students who had not signed up for the on-line discussion group were using the Web-site to check outlines posted for the course lectures.

Course Successes

- active participation - students help develop the learning materials; they tutor fellow-students in Web-based skills
- learning in a social contextual process – development of glossary

- learning in different ways - multiple approaches to the course material

Future directions

The next stage of development is relying heavily on the input of the on-line group. They have emphasized the need for several enhancements. These include:

- an on-line interactive time-line
- on-line short-answer quizzes and short essay questions
- on-line maps customized to reflect what is stressed in lectures
- expansion of opportunities for more students to participate in on-line learning

The instructor plans to involve more students in building the Web-site so that more of the class can experience the sense of ownership and empowerment that results from being an integral part of the development team.

Student evaluations of the course will be expanded considerably. There will be three opportunities in the academic year for feedback, two of these being designed to solicit "student-directed" feedback, consistent with the learner-centred approaches Dr. Kubicek has deployed throughout the project.

4. Botany - *Searchable plant images on-line.*

Botany tends to be a visually-oriented scientific discipline that has traditionally relied heavily on classroom presentations using projected images that are not generally available to the students outside of lectures. The primary aim of this project was to develop a means of providing twenty-four-hour access to these images for student review, reference and self-directed learning.

WebCT again provided the tools that enabled laboratory instructor Shona Ellis and her team of undergraduate student assistants to construct a course Web-site that included course notes, laboratory quizzes and approximately 300 images. Students in the course were introduced to the course Web-site at their initial lab session. They were given an outline that introduced the "look and feel" of the Web-site and received some hands-on training in how they could use its various sections. Students could access the lab materials at booked lab times and during evening drop-in times, from an on-campus Science computer laboratory. They could also access the materials from home via the Internet. During the laboratory section of the course, students worked on ten on-line exercises (one each week). To complete these exercises, they needed to use the resources on the course Web-site as well as reference information gained by searching other non-UBC Web-sites. The lab exercises had specific due dates and completed exercise answers were submitted electronically.

Course Successes

- active learning in the laboratory – on-line images, exercises
- individual learning – Web-based materials

- social contextual process - on-line discussion forum allowed interaction outside of class time with laboratory instructor and fellow students

Approximately 100 students were enrolled in the course and their feedback on the laboratory Web-site was overwhelmingly positive. A typical student response was "a very good spot to clear up questions about lab and lecture, nice to have access to slides and pictures in the notes."

Future directions

In the next version of the course, the images will be placed in a separate, searchable image archive. Students will thus have better access to the images and will be able to search for specific attributes of a particular plant specimen.

The complexity of the on-line lab quizzes will be increased, as it is now clear that the technology itself is not a barrier to student learning.

The senior course instructor needs to become more involved in the Web-site, illustrating his lectures with images from the site. This may be difficult, however, as the person who will be in charge of the laboratory next year, has no interest in the Web-site.

5. Geology - *Earth and Life Through Time.*

This evolutionary biology course is designed for third and fourth year science students whose major focus of study is not geology. Twenty-four students took the course in 1996. Drs. Paul Smith and Michelle Lamberson created a course Web-site whose primary goal was to put the tools and responsibility for learning in the students' hands. The site contains a well-organized set of course notes created by an undergraduate student who had previously taken the course. She worked closely with the faculty members but was given considerable autonomy to present the notes and images in a way that would provide alternative pathways to explore the course material. One student commented, "When reading the notes from the Web, [I found] they were different than those from class and different from the focus of the [text]book. This was more interesting and provided three different sources for approaching topics in case one wasn't clear."

The Web-site included all of the images shown in lectures: important fossils, diagrams and figures. As in the highly visual Botany course (case study 4), students were able to access these images on their own and to study them in more depth than is possible when they appear fleetingly in a class situation.

One particularly innovative feature of this Web-site was a computer model of accretionary shell development that allowed students to manipulate the parameters that determine how a spiral-shaped shell can be formed. The shell model helped students apply their knowledge of the morphology of modern accretionary shells to understanding the evolution of extinct life forms. Armed with the theoretical basis of spiral shell formation, the students were able to vary

parameters in a computer simulation and "draw" morphologies that occur in the modern and/or fossil record, as well as morphologies that have rarely or never evolved. This ability to visually "interpret" an abstract mathematical construct is a powerful use of computer technology, and facilitates student understanding of an important biological concept in a way that traditional approaches cannot.

Course Successes

- active participation - Web-site and the computer model
- variety of learning styles accommodated - visual learners benefited from the highly visual material available to them on the Web
- different approaches to the material - opportunity to synthesize the three different but complementary approaches to course content (lecture, on-line notes and textbook)

The instructor notes, however, that "this also unsettles some students who seem to need the comfort of a linear text wherein all wisdom is contained."

Future directions

In response to student requests, short self-testing questions are being created for each course topic as a way for the students to review their understanding of the material.

Since there was no pre-laboratory introduction to the shell-growth model, students tended to manipulate the parameters arbitrarily. This allowed them to make interesting shapes but distracted them from exploring the relationship of parameter values to observed patterns of shell evolution. The process of introducing the shell accretionary computer model will therefore be changed. The instructor will project the computer model in class, demonstrate the manipulation possibilities and explain the theoretical constructs behind the results. The students will thus be better prepared for their own investigations.

6. German - *Multimedia Reading Course.*

This multimedia course developed by Professor Joerg Roche focuses on the development of specialized reading skills in German for students who need reading competency for professional and/or scientific purposes. The pedagogic approach exploits the learner's familiarity with discipline-specific professional and/or technical subject matter. Learners can thus quickly identify and understand subject matter vocabulary embedded in German texts. The multimedia exercises (up to ten different types of self-testing exercises) incorporate real-life graphical elements representative of the field of study. The Business and Economics module, for example, contains spreadsheets, charts, advertisements and other graphics representative of contemporary business situations, while the Music module features a large number of audio recordings pertaining to specific reading texts and tasks.

The course is organized in two modules. The first module (Level 1), equivalent to a one-semester course, introduces reading strategies, reading grammar and basic vocabulary. Students who successfully complete the first module generally attain a second-year level of German reading competence. The Level 2 modules deal with specific reading competencies in four discipline areas: humanities, business and economics, chemistry and music. Environmental studies and theology modules are being developed. Students completing Level 2 are able to read German scholarly literature in their field (two semesters total study time).

The modules are accompanied by their own textbook and can be run from a CD-ROM or in a client-server environment, making them very suitable for a distance learning mode.

This course has become extremely popular, partly because of its independent learning format. Introduced into the UBC curriculum in September 1996, enrolment in the course has increased by approximately 400 per cent. Students decide the pace of their learning according to their individual learning and reading style. Like Web-based approaches, student learning is not tied to specific classroom hours. The design of the modules is such that minimal tutoring by an instructor is required.

Course Successes

- participatory learning - highly interactive program
- accommodates a variety of learning approaches – different exercise types
- self-paced
- learning in a social context - course materials are embedded in the current North American cultural environment

Future directions

Dr. Roche is considering implementing links to discipline-specific Web-sites so that students will experience the engagement that the dynamic nature of the Web engenders. He is planning reading courses in other languages, for example, an introductory business module for Japanese as a foreign language. He is also exploring the possibility of teaching the language skills of writing, speaking and listening, by expanding on the current approach.

Conclusion

These six case studies from UBC illustrate some of the powerful ways in which multimedia can be used to create effective learning environments and resources for university students in a variety of disciplines. An underlying theme in all the projects is encouragement of students to become more independent in terms of structuring their learning rather than depending on instructors as their sole source of knowledge. This represents a major shift in the instructional paradigm but the convergence of growing student dissatisfaction with traditional, passive,

instructor-centred teaching approaches and the availability of new technologies that can facilitate the transition to a more learner-centred approach, make it likely that we will see continue expansion of the array of well-designed, multimedia-based learning experiences.